

Remarks

This Preliminary Amendment cancels without prejudice original claims 1 to 8 in the underlying PCT Application No. PCT/DE02/03564. This Preliminary Amendment adds new claims 9 to 21. The new claims, *inter alia*, conform the claims to United States Patent and Trademark Office rules and do not add new matter to the application.

In accordance with 37 C.F.R. § 1.125(b), the Substitute Specification (including the Abstract, but without claims) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to United States Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. §§ 1.121(b)(3)(ii) and 1.125(c), a Marked-Up Version of the Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. Approval and entry of the Substitute Specification (including Abstract) are respectfully requested.

The underlying PCT Application No. PCT/DE02/03564 includes an International Search Report, dated April 4, 2003, a copy of which is included. The Search Report includes a list of documents that were uncovered by the Examiner in the underlying PCT application. A copy of the Search Report accompanies this Preliminary Amendment.

It is respectfully submitted that the present invention is new, non-obvious, and useful. Prompt consideration and allowance of the claims are respectfully requested.

Respectfully Submitted,

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DEVICE FOR MEASURING FILL LEVELS

FIELD OF THE INVENTION

The present invention relates to a device for measuring fill levels ~~according to the definition of the species in Claim 1.~~

5 ~~The device is, and relates~~ particularly suitable to a device for use as a fill level sensor for liquids.

BACKGROUND INFORMATION

10 Different fill level sensors which utilize different physical effects are known ~~from~~ in the ~~related~~ art. A capacitive sensor having a changeable dielectric is a possible design, in which, during a change in the fill level, the dielectric proportion of the medium to be measured changes within the capacitor,
15 thereby causing a capacitance change. The fill level may be determined based on the capacitance change. Plate capacitors or flat capacitors (inter-digital structures) designed on the basis of printed boards or punchings are possible, in addition to a design ~~as~~ utilizing a cylinder capacitor having the
20 appropriate coaxial structures.

The object of the present invention is to provide a device for measuring fill levels which may be manufactured cost-effectively and which enables measuring as accurately as
25 possible.

SUMMARY

30 ~~According to the present invention the object is achieved by a device having the features of Claim 1. Advantageous~~

~~embodiments and refinements are described in the subclaims.~~

~~Due to the design of the~~ The present invention provides a
sensor using two base components, from each of which project
5 finger-shaped electrodes, ~~situated~~ offset from one
~~another[[],]. In this manner, it is possible to implement a~~
total capacitance of the device is achieved by multiplying the
single capacitances by the number of electrode pairs, thereby
approximately achieving a proportional ratio of the pairs of
10 electrodes, submerged in the medium, to the total capacitance.
Using a fixing element, the base components are positioned
with respect to one another in such a way that a continuous
allocation takes place among the electrodes, and such hat a
minimum interfering proportion of other materials is situated
15 between the electrodes, in order to achieve highest measuring
~~as accurately~~ accuracy as possible. Furthermore, rapid flow-
off or discharge of the medium during fluctuating fill levels
is achieved due to the open structure in the overlapping area
of the electrodes, so that a swift response to changing fill
20 levels may take place.

~~A refinement~~ An example embodiment of the present invention
provides that the sensor has a meander-shaped inter-digital
structure, whereby a simple computation of the total
25 capacitance during changing fill levels may be possible.
Inter-digital structure means that there are spaces between
the finger-shaped electrodes, into which spaces corresponding
finger-shaped electrodes of another base component may be
inserted or introduced. There is still a gap between the
30 electrodes of the two base components, which gap is filled by
the medium to be measured. A meander-shaped path, facilitating
a flow-off of the medium to be measured during fill level
changes or fluctuations, is formed due to the meandering path
of the gaps between the electrodes.

To achieve a design that is as compact as possible, it is provided according to the present invention that the electrodes of the base components are situated essentially in a plane, so that the sensor has a planar structure.

To improve the flow-off characteristics of the medium to be measured, it is provided according to the present invention that the electrodes are tapered starting from the base component, thereby additionally improving the electrodes's mechanical stability.

Manufacturing the fixing element by using plastic injection molding or plastic extrusion coating is a ~~very~~ cost-effective way of aligning the electrodes and the base components to one another, ~~it is a tried and tested method,~~ with which method great quantities of sensors having sufficient accuracy may be manufactured. Great position accuracy of the base components, and thus of the electrodes, is achieved by designing the fixing element as a frame, in particular as a closed frame; the frame may also be manufactured by using plastic extrusion coating. Since the extrusion coating material is not situated in the overlapping area of the electrodes, i.e., between the electrodes, the extrusion coating material does not act as a dielectric, and thus the total capacitance, and ~~thus~~ in turn the measuring accuracy, is not affected.

In order to manufacture the sensor as cost-effectively as possible, it is provided that the base component and the electrodes are manufactured from a pressed screen, ~~preferably~~ e.g., in one piece, the pressed screen ~~preferably~~ being made of a metal which has robust characteristics in the medium surrounding it. As an alternative to such a material selection, ~~it is provided to coat~~ the electrodes and ~~possibly~~ optionally the base component may be coated with a protective coating to protect the electrodes against corrosive media.

✓ ~~The present invention is explained in greater detail below on the basis of an exemplary embodiment.~~
~~The sole figure shows.~~

5 BRIEF DESCRIPTION OF THE DRAWING

Figure ~~[[-]]~~ shows a schematic representation of a measuring device according to the present invention.

10 DETAILED DESCRIPTION

The figure shows a schematic representation of a sensor 1, ~~sensor 1 being~~ which is made up of two base components 2, 3, from each of which electrodes 20, 30 project in one direction.
15 Electrodes 20, 30 are situated in a plane in the illustrated exemplary embodiment; alternative embodiments or alternative spatial positioning of electrodes 20, 30 may also be provided. Electrodes 20, 30 of both base components 2, 3 face each other and are situated offset from one another in such a way that a
20 meander-shaped gap forms between electrodes 20, 30, into which gap a medium (not shown), a liquid, for example, may penetrate. As a result of this medium's penetration, the total capacitance of sensor 1 changes due to the medium's different dielectric constant in relation to air. Depending on the fill
25 level, the capacitance between the pairs of electrodes thus changes; an electronic unit (not shown) analyzes the capacitance signal and conveys it to a display device or regulates a system correspondingly based on the measured value.

30 Outside the overlapping area of electrodes 20, 30, i.e., the area in which electrodes 20, 30 do not mesh with one another, a circumferential frame 4 is injection molded onto base components 2, 3 to reliably and inexpensively fix electrodes
35 20, 30 in position. Finger-shaped electrodes 20, 30 are thus supported on one side on the respective base components 2, 3

✓ and, due to frame 4, the plastic proportion between electrodes 20, 30 is negligibly small with regard to the electric capacitance. This, in particular, has the advantage of providing increased measuring accuracy, since conventional plastics have a high temperature sensitivity with respect to the relative dielectric constants, so that, in the presence of plastic materials between the electrodes, great non-linear changes in the partial capacitance and great non-linear temperature changes make an exact analysis of the fill level impossible difficult.

The planar structure according to the present invention ~~implements~~ provides free-standing electrodes 20, 30 in the overlapping area, thereby making the plastic proportion negligible with respect to the capacitance, and at the same time, a meander-shaped gap is achieved between electrodes 20, 30, through which gap the flow-off of the liquid or the medium is definitely improved. In the exemplary embodiment illustrated, electrodes 20, 30 are tapered starting from the particular base component 2, 3 ($W_1 > W_2$), whereby the mechanical stability of electrodes 20, 30, as well as the flow-off characteristics, are further improved.

The structure of sensor 1 may be produced using a pressed screen which, for fixing purposes, is extrusion-coated with a closed or open plastic frame 4. Provided that frame 4, and thus the entire measuring capacitance, is submerged into the medium to be measured, sensors for detecting the relative dielectric constants may also be implemented in this way.

Abstract

ABSTRACT

A device for measuring fill levels, in particular liquid fill levels, is ~~described~~ provided, ~~having which device has~~ a capacitive sensor (1) and, connected to the sensor (1), a unit for analyzing a measuring signal from the sensor (1). The ~~object is to provide a device for measuring fill levels which may be manufactured cost-effectively and which enables highly accurate measurements measuring as accurately as possible.~~ The ~~object is achieved in that the~~ sensor (1) has at least two base components (2, 3) including finger-shaped electrodes (20, 30) projecting therefrom~~[[,]]. that the~~ The electrodes (20, 30) are situated offset from one another, and ~~that~~ the base components (2, 3) are fixed in position with respect to one another by at least one fixing element (4), the fixing element (4) being situated outside the overlapping area of the electrodes (20, 30).